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(54) Title of the invention: Routing area updating in packet radio network
(57) Abstract:

The invention relates to a cellular packet radio network and to a method for updating a routing area in a packet radio network. Packet radio support nodes (SGSN) are connected to a digital cellular radio network (BSS) that provides a radio interface for the support nodes for packet-switched data transmission between the support nodes and mobile stations.

There is a logical link between a mobile station (MS) and a serving packet radio support node (SGSN). The packet radio network uses logical routing areas, each of which includes one or more cells. Each cell broadcasts information on the routing area to which it belongs. The mobile station sends a routing area update request to the packet radio network when it roams to a new cell which belongs to a different routing area than the old cell. The update request includes the identifiers of the old and new routing area. When the packet radio node detects a routing area update carried out by an unknown mobile station, it initiates the establishment of a logical link by sending a link establishment message (LLC Subm, 21, 21') to the mobile station, the message including the same identifier the mobile station used for itself in the routing area update request. The mobile station initializes the logical link at its own end and sends and acknowledgement to the serving packet radio support node.

[Claims]

1. A method for updating a routing area in a packet radio network characterized by including the steps of establishing a logical link between a mobile station and the 1st radio support node by a radio cell, the mobile station selecting the 2nd radio cell on roaming, the routing area identifier broadcast by the 2nd cell that is different from the routing area identifier of the

1st radio cell, sending a routing area update request to the 2nd packet radio support node serving the 2nd cell from the mobile station detecting in the 2nd packet radio support node that the mobile station has roamed from a routing area served by a different packet radio support node, requesting subscriber data related to the mobile station from the 1st packet radio support node, sending an acknowledgement message on the routing area update from the 2nd packet radio support node to the mobile station, initiating a signaling procedure for initializing a logical link between the mobile station and the 2nd packet radio support node in the 2nd packet radio support node in response to detecting that the mobile station has roamed from a routing area served by a different packet radio support node.

2. The method according to claim 1 characterized by that the mentioned above local initialization of a logical link includes resetting of the state variables of the logical link in the mobile station.

3. The method according to claim 1 or 2 characterized by that the mentioned above local initialization of a logical link includes setting the link parameters of the logical link to their default values in the mobile station.

4. The method according to claims 1 to 3 characterized by that the mentioned above network procedure for initializing a logical link includes the steps of sending the 1st message of the logical link

protocol from the 2nd packet radio support node to the mobile station, resetting the state variables of the logical link in the mobile station in response to the mentioned above 1st message, sending a response message from the mobile station to the 2nd packet radio support node, resetting the state variables of the logical link in the 2nd packet radio support node.

5. The method according to claim 4 characterized by that the mentioned above packet radio network is a GPRS network and the mentioned above 1st message is the set asynchronous balanced mode command of the LAPG protocol and the mentioned above response message is the unnumbered acknowledgement response of the LAPG protocol.

6. The method according to claims 1 to 3 characterized by that the mentioned above signaling procedure for initializing a logical link includes the steps of performing negotiation of link parameters according to the logical link protocol between the mobile station and the 2nd packet radio support node, setting the link parameters to the negotiated values in the mobile station and 2nd support node, resetting the state variables of the logical link in the mobile station.

7. The method according to claim 6 characterized by that the packet radio network is a GPRS network and the mentioned above negotiation of link parameters includes the steps of sending a XID command of the LAPG protocol from the 2nd packet radio support

node to the mobile station, the command including a list of the link parameter values supported by the 2nd packet radio support node, sending a XID response of the LAPG protocol from the mobile station to the 2nd packet radio support node, the response including a list of the link parameter values requested by the mobile station, setting the link parameter values to the values given in the XID command in the mobile station and 2nd packet radio support node, resetting the state variables of the logical link in the mobile station.

8. The method according to claims 1 to 7 characterized by failing to retrieve packet data protocol parameters which the mobile station has activated in the 1st packet radio support node from the 1st packet radio support node for the 2nd packet radio support node, sending information from the 2nd packet radio support node to the mobile station that it should reactivate the packet data protocol parameters, sending a message for activating the packet data protocol parameters from the mobile station to the 2nd packet radio support node.

9. The method according to claim 8 characterized by that the packet radio network is a GPRS network and the mentioned above activation message is activate PDP context request.

10. The method according to claims 1 to 9 characterized by that the signaling procedure for initializing a logical link is performed before, simultaneously with or after requesting subscriber data from the 1st packet radio support node.

11. The method according to claim 8 characterized by that the packet radio network is a GPRS network and the mentioned above information on the need for activating the packet data protocol parameters is sent in a message of the mobility management protocol, for example, in the MM message routing area update accept.

12. A cellular packet radio network characterized by including mobile stations (MS), packet radio support nodes (SGSN) that are connected to a digital cellular radio network providing a radio interface for the support nodes for packet switched data transmission between the support nodes and mobile stations, there being a logical link between the mobile station and the serving packet radio support node, logical routing areas, each of which includes one or more cells in the radio network, each cell being arranged to broadcast information on the routing area to which it belongs, the mobile stations being arranged to send a routing area update request to the packet radio network when they roam to a new cell that belongs to a different routing area than the old cell, the mentioned above update request including identifiers of the old and new

routing area, the packet radio support node being arranged to request the mobile subscriber's data from the old packet radio support node upon detecting that the old routing area belongs to a different packet radio support node, the packet radio support node that is arranged to acknowledge the routing area update to the mobile station when the node has received the subscriber data, characterized by that the packet radio support node is arranged to initiate a signaling procedure for initializing a logical link between the mobile station and the 2nd packet radio support node in response to detecting that the mobile station has roamed from a routing area served by a different packet radio support node.

13. The packet radio network according to claim 12 characterized by that the packet radio support node is arranged to initiate the mentioned above signaling procedure before or at the same time as it retrieves the subscriber data from the old packet radio support node.

14. The packet radio network according to claim 12 or 13 characterized by that the initialization of a logical link includes resetting the state variables of the logical link and setting the link parameters of the logical link to their default values in the mobile station.

15. The packet radio network according to claims 12 to 14 characterized by that the mentioned above signaling procedure for initializing a logical link

includes a message of the 1st logical link protocol sent from the radio support node, the message causing resetting of the state variables of the logical link in the mobile station and a response message sent from the mobile station to the 2nd packet radio support node.

16. The packet radio network according to claim 15 characterized by that the mentioned above packet radio network is a GPRS network and the mentioned above 1st message is the set asynchronous balanced mode command of the LAPG protocol and the mentioned above response message is the unnumbered acknowledgement response of the LAPG protocol.

17. The packet radio network according to claims 12 to 14 characterized by that the mentioned above signaling procedure for initializing a logical link includes negotiation of link parameters according to a logical link protocol between the 2nd packet radio support node and the mobile station, the negotiation causing setting of the link parameters to the negotiated values in the mobile station and 2nd support node and resetting of the state variables of the logical link in the mobile station.

18. The packet radio network according to claim 17 characterized by that the packet radio network is a GPRS network and the mentioned above negotiation of the link parameters includes a XID command of the LAPG protocol sent from the 2nd packet radio

support node to the mobile station, the command including a list of the link parameter values supported by the 2nd packet radio support node and a XID response of the LAPG protocol sent from the mobile station to the 2nd packet radio support node, the response including a list of the link parameter values requested by the mobile station and the negotiation causing setting of the link parameters to the values given in the XID response in the mobile station and 2nd packet radio support node and resetting of the state variables of the logical link in the mobile station.

19. The packet radio network according to claims 1 to 18 characterized by that the mentioned above subscriber data include the packet data protocol parameters the mobile station has activated in the old packet radio support node the new packet radio support node is arranged to send information that it should reactivate the packet data protocol parameters in response to the unsuccessful search for the subscriber data from the old packet radio support node, the mobile station is arranged to send a message for activating the packet data protocol parameters to the packet radio support node in response to the mentioned above activation information.

20. The packet radio network according to claim 12 characterized by that the acknowledgement message on the routing area update includes the mentioned

above information on the change of the packet radio support node.

[Detailed description of the invention]

Routing area updating in packet radio network

Field of the invention

Generally, this invention relates to packet radio networks and in particular to supporting mobility in packet radio networks.

Background of the invention

Mobile communication systems developed because of necessity to reach people even when they are not close to a fixed telephone terminal. As the use of various data transmission services in offices has increased, different data services have also been introduced into mobile communication systems. Portable computers enable effective data processing wherever the user moves. Mobile communication networks in turn provide an effective access network to actual data networks for the user for mobile data transmission. To realize this, data services of new kind are designed for existing and future mobile communication networks. Mobile data transmission is supported particularly well by digital mobile communication systems, such as the European mobile communication system GSM (GSM system).

The general packet radio service GPRS is a new service in the GSM system and is one of the objects of the standardization work of the GSM phase 2+ at

ETSI (European Telecommunication Standard Institute). The GPRS operational environment includes one or more sub-network service areas that are interconnected by a GPRS backbone network. A sub-network includes a number of packet data service nodes SN, (serving GPRS support nodes SGSN), each of which is connected to the GSM mobile communication network (typically, to base station systems) in such a way that it can provide a packet service for mobile data terminals by several base stations, namely cells. The intermediate mobile communication network provides packet-switched data transmission between a support node and mobile data terminals. Different sub-networks are in turn connected to an external data network, for example, to a public switched data network PSPDN, by GPRS gateway support nodes GGSN. The GPRS service thus allows to provide packet data transmission between mobile data terminals and external data networks when the GSM network functions as an access network. The GPRS network architecture is represented on Drawing 1.

In the GPRS system, layered protocol structures known as a transmission level and a signaling level defined for transmitting user information and signaling (communication). A transmission level has a layered protocol structure providing transmission of user information together with control procedures of data transmission related to it (for example, flow control, error detection, error correction and error recovery). A signaling level consists of protocols which are used for controlling and supporting the functions of the transmission level, such as controlling access to the GPRS network (attach and detach) and controlling the routing path of the established network connection in order to support the user's mobility. Drawing 2 shows the signaling level of the GPRS system between MS and SGSN. The protocol layers of the transmission level are identical with those of Drawing 2 up to protocol layer SNDCP, above which there is a protocol of the GPRS backbone network (for example, Internet Protocol IP) between the MS and the GGSN (instead of protocol L3MM). The protocol layers represented on Drawing 2, Layer 3 Mobility Management (L3MM): This protocol supports the functionality of mobility management, for example, GPRS Attach, GPRS Detach security, routing update, location update, activation of a PDP context and deactivation of a PDP context. Sub-network Dependent Convergence Protocol (SNDCP) supports transmission of protocol data units (N-PDU) of a network layer between an MS and an SGSN. The SNDCP layer, for example, manages ciphering and compression of N-PDU.

Logical Link Control (LLC): this layer provides a very reliable logical link. The LLC is independent of the radio interface protocols mentioned next.

LLC Relay: This function relays LLC protocol data units (PDU) between MS-BSS interface (Um) and a BSS-SGSN interface (Gb).

Base Station Subsystem GPRS Protocol (BSSSGP): This layer transmits routing information and information related to QoS between BSS and SGSS.

Frame Relay that is used over the Gb interface. A semi-permanent connection for which several subscribers' LLC PDUs are multiplexed is established between the SGSN and the BSS.

Radio Link Control (RLC): This layer provides a reliable link independent of radio solutions.

Medium Access Control (MAC): This one controls access signaling (request and grant) related to a radio channel and mapping of LLC frames onto a physical GSM channel.

According to the invention the most interesting protocol layers are the LCC and L3MM. The function of the LLC layer can be described: the LLC layer functions above the RLC layer in the reference architecture and establishes a logical link between the MS and its serving SGSN. According to the function of the LCC the most important requirements are a reliable management of LCC frame relay and support for point-to point and point-to-multipoint addressing.

The service access point (SAP) of the logical link layer is a point where the LLC layer provides services for the protocols of layer 3 (SNDCP layer in Drawing 2). The link of the LLC layer is identified with a data link connection identifier (DLCI) that is transmitted in the address field of each LLC frame. The DLCI consists of 2 elements: Service Access Point Identifier (SAPI) and Terminal End Point Identifier (TEI). The TEI identifies a GPRS subscriber and is usually a Temporary Logical Link Identity TLLI. Also, the TEI can be another subscriber identity, such as an international mobile subscriber identity IMSI, but usually transmission of the IMSI on the radio path is avoided.

When a user attaches to a GPRS network, a logical link is established between the MS and the SGSN. Thus it can be the mentioned above that the MS has a call in progress. This logical link has a route between the MS and the SGSN, indicated with the TLLI identifier. Thus the TLLI is a temporary identifier, the SGSN of which allocates for a certain logical link and IMSI. The SGSN sends the TLLI to the MS in connection with the establishment of a logical link and it is used as an identifier in later signaling and data transmission over this logical link.

Data transmission over a logical link is carried out as explained in the following.

The data to be transmitted to or from an MS is processed with an SNDCP function and transmitted to the LLC layer. The LLC layer inserts the data in the information field of LLC frames. The address field of a frame includes for example, a TLLI. The LLC layer relays the data to the RLC that deletes unnecessary information and segments the data into a form compatible with the MAC. The MAC layer activates radio resource processes in order to obtain a radio traffic path for transmission. A corresponding MAC unit on the other side of the radio traffic path receives the data and relays it upwards to the LLC layer. Finally, the data is transmitted from the LLC layer to the SNDCP, where the user data is restored completely and relayed to the next protocol layer. LLC layer controls transmission and retransmission of LLC frames over a logical link. Several state variables are related to the controlling at both ends of the link. In multi-frame transmission such state variables include for example, a transmission state variable V(S), acknowledgement state variable V(A), transmission sequence number N(S), receiving state variable V(R) and receiving sequence number N(R). The V(S) indicates the number of the frame to be transmitted next. The V(A) indicates the number of the last frame the opposite end has acknowledged. The V(S) shall not exceed the V(A) by more than k frames, namely the size of the transmission window is

k. The V(R) indicates the number of the next frame that is expected to be received. The state variables are reset, namely set to value 0 when a logical link is being established. This is performed by using the following messages of the LAPG (Link Access Procedure on the «G» channel) protocol: SABM (set asynchronous balanced mode) and UA (unnumbered acknowledgement) or SAUM (set asynchronous unbalanced mode).

3 different MM states of the MS are typical of the mobility management (MM) of a GPRS subscriber: idle state, standby state and ready state. Each state represents a certain functionality and information level that has been allocated to the MS and SGSN. Information sets related to these states, called MM contexts, are stored in the SGSN and MS. The context of the SGSN includes subscriber data, such as the subscriber's IMSI, TLLI and location and routing information.

In the idle state the MS cannot be reached from the GPRS network and no dynamic information on the current state or location of the MS, namely on the MM context, is maintained in the network. The MS neither receive nor transmit data packets, in consequence of which no logical link has been established between the SGSN and the MS. If the MS is a dual-mode terminal, namely it can function both in the GPRS network and in the GSM network, it can be in the GSM network when functioning in the GPRS idle state. The MS can switch from the idle state to the ready state by attaching to the GPRS network and from the standby or ready state to the idle state by detaching from the GPRS network.

In the standby and ready states the MS is attached to the GPRS network. In the GPRS network, a dynamic MM context has been created for the MS and a logical link LLC (Logical Link Control) established between the MS and the SGSN in a protocol layer. The ready state is the actual data transmission state, in which the MS can transmit and receive user data. The MS switches from the standby state to the ready state either when the GPRS network pages the MS or when the MS initiates data transmission or signaling. The MS may remain in the ready state (for a period set with a timer) even when no user data is transmitted nor signaling performed.

Also, in the standby and ready states the MS has one or more PDP contexts (Packet Data Protocol) that are stored in the serving SGSN in connection with the MM context. The PDP context defines different data transmission parameters, such as the PDP type (for example, X.25 or IP), PDP address (for example, X.121 address), quality of service QoS and NSAPI. The MS activates the PDU context with a specific message, Activate PDP Context Request, in which it gives information on the TLLI, PDP type, PDP address, required QoS and NSAPI. When the MS roams to the area of a new SGSN, the new SGSN requests MM and PDP contexts from the old SGSN. For mobility management, logical routing areas have been defined to the GPRS network. A routing area RA is an area defined by an operator, including one or more cells. Usually, 1 SGSN serves several routing areas. A routing area is used for determining the location of the MS in the standby state. If the location of the MS is not known in terms of a specific cell, signaling is started with a GPRS page within one routing area RA.

The MS performs a routing area update procedure in order to support mobility of a packet-switched logical link. In the ready state the MS initiates the procedure when a new cell is selected, the routing area changes or the update timer of a cyclic routing area expires. The radio network (PLMN) is arranged to transmit a sufficient amount of system information to the MS, so that it can detect when it enters a new cell or a new routing area RA and to determine when it is to carry out cyclic routing area updates. The MS detects that it has entered a new cell by comparing cyclically the cell identity (Cell ID) which is stored in its MM context with the cell identity which is received from the network. Correspondingly, the MS detects that it has entered a new routing area RA by comparing the routing area identifier stored in its MM context with the routing area identifier received from the network. When the MS selects a new cell, it stores the cell identity and routing area in its MM context.

All procedures described above (for example, attach, detach, routing area update and activation/deactivation of the PDP context) for creating and updating MM and PDP contexts and establishing a logical link are procedures activated by the MS. In connection with a routing area update the MS, however, carries out an update to the new routing area without being able to conclude on the basis of the routing area information broadcast by cells whether the SGSN serving the new cell is the same as the SGSN that served the old cell. On the basis of the old routing area information transmitted by the MS in an update message the new SGSN detects that a routing area update is in progress between SGSNs and activates necessary interrogations to the old SGSN in order to create new MM and PDP contexts for the MS to the new SGSN. Since the SGSN has changed, the logical link should be re-established between the MS and the new SGSN. The problem is, however, that the MS does not know that the SGSN has changed. Instead, the MS may transmit data to the new SGSN that is not able to unpack the data before MM and PDP contexts have been created on the basis of the inquiry made to the old SGSN. Furthermore, even though the contexts were already created in the new

SGSN, state variables at the ends of the logical link do not match and data transmission fails, at least temporarily. If the retrieval of PDP contexts from the old SGSN fails, data transmission is prevented, since the new SGSN does not serve according to the PDP context activated earlier by the MS. The MS, however, has no information on such a situation and it cannot start reactivation of the PDP context.

Disclosure of this invention

An object of the invention is to minimize and eliminate the problems and disadvantages resulting from the routing area update.

The invention relates to a method for updating a routing area in a packet radio network including the steps of establishing a logical link between a mobile station and the 1st radio support node by a radio cell, the mobile station selecting the 2nd radio cell on roaming, the routing area identifier broadcast by the 2nd cell being different from the routing area identifier of the 1st radio cell, sending a routing area update request to the 2nd packet radio support node serving the 2nd cell from the mobile station, detecting in the 2nd packet radio support node that the mobile station has roamed from a routing area served by a different packet radio support node, requesting subscriber data related to the mobile station from the 1st packet radio support node, sending an acknowledgement message on the routing area update from the 2nd packet radio support node to the mobile station. The method is characterized by initiating a signaling procedure for initializing a logical link between the mobile station and the 2nd packet radio support node in the 2nd packet radio support node in response to detecting that the mobile station has roamed from a routing area served by a different packet radio support node.

The basic idea of the invention is that the serving packet radio support node that detects a routing area update performed by an unknown mobile station, initiates the establishment of a logical link by sending a link establishment message to the mobile station, the message including the same identifier the mobile station used for itself in the routing area update request. The mobile station initializes the logical link at its own end and sends an acknowledgement to the serving packet radio support node. The initialization of the logical link performed by the mobile station may include resetting the state variables of the logical link and changing the new identifier possibly sent by the support node in the mobile station. Default values, for example, can be used for other possible link parameters.

The establishment message of a logical link may be any message or a sequence of messages indicating the establishment or re-initialization of a logical link. It is preferably possible to use messages similar to the ones the mobile station employs for initiating the establishment of a logical link on attaching to the network for the 1st time. In a preferred embodiment of the invention the serving packet radio node SGSN of the GPRS system sends a SABM command (set asynchronous balanced mode) of the LAPG protocol (link access procedure on the «G» channel) to the mobile station and the mobile station acknowledges it by sending an UA response (unnumbered acknowledgement). Another preferred solution is to use the negotiation procedure of LLC link parameters of the GPRS system in such a way that the serving support node sends a XID command to the mobile station, the command including a parameter message. The mobile station sends a XID reply message including a list of the parameters it supports. When resetting of the state variables according to the invention (or another kind of initialization of the logical link) is added to this in the mobile station in response to the XID command, desirable link parameters can be provided with very little signaling. As was mentioned above, in some exceptional situations the packet data protocol context (PDP) cannot be retrieved for the new support node from the old support node. This may result for example, from the fact that the new support node does not recognize the old support node or cannot contact it or the old support node has lost the subscriber data.

In that case, in one preferred embodiment of the invention, the new support node sends information to the mobile station that it should initiate the activation procedure of a PDP context (contexts). This information can be relayed as included in the information on the change of the support node or as separate information. Without this procedure the new support node cannot function in the way defined earlier by the mobile station and data transmission is prevented at least temporarily without the mobile station detecting this.

According to the embodiment of the invention, the new support node initiates the establishment of a logical link immediately after having detected that the support node has changed. Thus the establishment signaling of a logical link can be performed at the same time as the new support node searches for subscriber data from the old support node or the subscriber data base. An advantage resulting from this is that the mobile station does not try to transmit more data packets since it thinks that it still has a link to the old support node. Furthermore, the update of the logical link can be initiated as early as possible that speeds up the initiation of data transmission after subscriber data have been received in the support node. If the new support node does not accept the link to the mobile station after the subscriber data have been checked, the support node disconnects the established logical link by sending a disconnect message to the mobile station. In the GPRS system a message suitable for this purpose is, for example, the DISC command (Disconnect) of the LAPG protocol. The invention provides an effective way for re-establishing a logical link between support nodes in connection with a routing area update. The invention allows to avoid completely the update of the logical link and interruptions to data transmission in connection with an intra-support node routing area update. The above mentioned problem would arise, for example, in such a solution in which the mobile station would always initiate reestablishment of a logical link in connection with a routing area update as a precaution.

Brief description of the drawings

In the following, the invention will be described in details by means of preferred embodiments with reference to the attached drawings.

Drawing 1 shows GPRS network architecture.

Drawing 2 shows protocol layers of the signaling level between an MS and an SGSN.

Drawing 3 is a signaling diagram that shows a routing area update according to the invention.

Preferred embodiments of the invention

The present invention can be applied to packet radio systems of different kinds. The invention can be especially preferably used for providing a general packet radio service GPRS in the European digital mobile communication system GSM (GSM System) or in corresponding mobile communication systems, such as DCS1800 and PCS (Personal Communication System). In the following, the preferred embodiments of the invention will be described by means of a GPRS packet radio network formed by the GPRS service and the GSM system without limiting the invention to this particular packet radio system. Drawing 1 shows a GPRS packet radio network implemented in the GSM system.

The basic structure of the GSM system includes 2 elements: a base station system BSS and a network subsystem NSS. The BSS and mobile stations MS communicate over radio links. In the base station system BSS each cell is served by a base station BTS. A number of base stations are connected to a base station controller BSC that controls the radio frequencies and channels used by the BTS. Base station controllers BSC are connected to a mobile services switching centre MSC. As regards a more detailed description of the GSM system, reference is made to the ETSI/GSM recommendations and The GSM System for Mobile Communications, M. Mouly and M. Pautet, Palaiseau, France, 1992, ISBN: 2-957190-07-7.

In Drawing 1 the GPRS system connected to the GSM network includes one GPRS network that in turn includes 2 serving GPRS support nodes (SGSN) and one GPRS gateway support node (GGSN). The different support nodes SGSN and GGSN are interconnected by an intra-operator backbone network. It is important to realize that in the GPRS network there may be any number of support nodes and gateway support nodes.

The serving GPRS support node SGSN is a node which serves the mobile station MS. Each support node SGSN controls a packet data service within the area of one or more cells in a cellular packet radio network and thus, each support node SGSN is connected (Gb interface) to a certain local element of the GSM system. This connection is typically established to the base station system BSS, namely to base station controllers BSC or to a base station BTS. The mobile station MS located in a cell communicates with a base station BTS over a radio interface and further with the support node SGSN to the service area of which the cell belongs through the mobile communication network. In principle, the mobile communication network between the support node SGSN and the mobile station MS only relays packets between these two. To realize this the mobile communication network provides packet-switched transmission of data packets between the mobile station MS and the serving support node SGSN. It has to be noted that the mobile communication network only provides a physical connection between the mobile station MS and the support node SGSN and thus its exact function and structure is not significant with respect to the invention. The SGSN is also provided with a signaling interface Gs to the visitor location register VLR of the mobile communication network and/or to the mobile services switching centre, for example, signaling connection SS7. The SGSN may transmit location information to the MSCNLR and/or receive requests for paging a GPRS subscriber from the MSCNLR.

When the MS attaches to the GPRS network, namely in a GPRS attach procedure, the SGSN creates a mobility management context (MM context) including information related to the mobility and security of the MS, for example, in connection with a PDP activation procedure the SGSN creates a PDP context (packet data protocol) which is used for routing purposes within the GPRS network with the GGSN which the GPRS subscriber uses.

The GPRS gateway support node GGSN connects an operator's GPRS network to other operators' GPRS systems and to data networks 11 12, such as an inter-operator backbone network, IP network (Internet) or X.25 network. The GGSN includes GPRS subscribers' PDP addresses and routing information, namely SGSN addresses. Routing information is used for tunneling protocol data units PDU from data network 11 to the current switching point of the MS, namely to the serving SGSN. Functionalities of the SGSN and GGSN can be integrated into the same physical node.

The home location register HLR of the GSM network includes GPRS subscriber data and routing information and maps the subscriber's IMSI into one or more pairs of the PDP type and PDP address. The HLR also maps each PDP type and PDP address pair into one or more GGSNs. The SGSN has a Gr interface to the HLR (a direct signaling connection or by an internal backbone network 13). The HLR of a roaming MS may be in a different mobile communication network than the serving SGSN.

An intra-operator backbone network 13 that interconnects an operator's SGSN and GGSN equipment can be implemented, for example, by means of a local network, such as an IP network. It should be noted that an operator's GPRS network can also be implemented without the intra-operator backbone network, for example, by providing all features in one computer.

An inter-operator backbone network is a network by which different operators' gateway support nodes GGSN can communicate with one another.

In the following, the routing area update in the GPRS network will be described in details. The MS carries out a routing area update procedure in order to support mobility of a packet-switched logical link. The MS initiates the procedure when a new cell is selected and the routing area RA changes or when the cyclic update timer of a routing area expires. The radio network (PLMN) is arranged to transmit a sufficient amount of system information to the MS so that it can detect when it enters a new cell or routing area RA and to determine when it is to carry out cyclic routing area updates.

The MS detects that it has entered a new cell by comparing cyclically the cell identity (Cell ID) which is stored in its MM context with the cell identity which is received from the network. Correspondingly, the MS detects that it has entered a new routing area RA by comparing the routing area identifier stored in its MM context with the routing area identifier received from the network.

When the MS detects a new cell or a new routing area RA, this means that one of the three possible cases is in question: 1) a cell update is needed; 2) a routing area update is needed and 3) a combined update of a routing area and location area is needed. In all these 3 cases the MS selects a new cell locally and stores the cell identity in its MM context.

Cell update procedure A cell update is performed when the MS enters a new cell within the current routing area RA and is in the ready state. If the RA has changed, a routing area update is carried out instead of the cell update.

The cell update procedure is carried out as an implicit procedure at the LLC level that means that normal LLC information and control frames are used for sending information on crossover to the SGSN. In transmission toward the SGSN, the cell identity is added to all LLC frames in the base station system of the network. The SGSN registers the crossover of the MS and any further traffic toward the MS is routed by a new cell. In a simple cell update the SGSN does not change and problems overcome by the invention will not arise.

Update procedure of routing area

A routing area is updated when an MS attached to the GPRS network detects that it has entered a new routing area RA or when the cyclical RA update timer has expired. When the SGSN detects that it is also controlling the old routing area, it finds out that an intra-SGSN routing update is in question. In this case the SGSN has the necessary information on the MS and it does not need to inform the GGSNs, HLR or MSCNLR of the new location of the MS. The cyclical RA update is always an intra-SGSN routing area update.

In the intra-SGSN routing update procedure the SGSN will not change either and no problems overcome by the invention will arise.

Inter-SGSN routing area update

In the routing area update procedure between 2 SGSN (inter SGSN) the serving SGSN changes and, according to the invention, the MS should be informed of the change, so that the MS can initiate a local procedure or a network procedure for updating a logical link. In the following, the inter SGSN routing area update according to the 1st embodiment of the invention will be described with reference to Drawing 3. In the following description the reference numbers refer to messages or events shown on Drawing 3.

1. The MS sends a routing area update request to the SGSN. This message includes the temporary logical link identity TLLI, cell identity of the new cell Cellid, routing area identifier of the old routing area RAid and routing area identifier of the new routing area RAid. If load is to be decreased in the radio interface, the cell identity Cellid is not added until in the base station system BSS.
2. The new SGSN detects that the old routing area belongs to another SGSN that will be referred to as an old SGSN in this context. As a result, the new SGSN requests MM and PDP contexts for the MS in question from the old SGSN. All contexts can be requested at the same time or the MM context and

each PDP context can be requested in different messages. The request (requests) includes at least the routing area identifier RAid of the old routing area and the TLLI. The old SGSN sends in response an MM context, PDP contexts and possibly authorization parameter triplets. If the MS is not recognized in the old SGSN, the old SGSN replies with an appropriate error message. The old SGSN stores the new SGSN address until the old MM context has been deleted so that data packets can be relayed from the old SGSN to the new SGSN.

3. The new SGSN sends a message «Modify PDP context request» including for example, a new SGSN address to the GGSN concerned. The GGSN update their PDP context fields and send in response a message «Modify PDP context response».
4. The SGSN informs the HLR of the change of the SGSN by sending it a message «Update location» including a new SGSN address and IMSI.
5. The HLR deletes the MM context from the old SGSN by sending it a message «Cancel location» including an IMSI. The old SGSN deletes the MM and PDP contexts and acknowledges this by sending a message «Cancel location ack».
6. The HLR sends a message «Insert subscriber data» including an IMSi and GPRS subscriber data to the new SGSN. The SGSN acknowledges this by sending a message «Insert subscriber data ack».

7. The HLR acknowledges the location update by sending a message «Update location ack» to the SGSN.

8. Also, if the subscriber is a GSM subscriber (IMSI-Attached), the association between the SGSN and the VLR has to be updated. The VLR address is deduced from the RA information. The new SGSN transmits messages «Location updating request» including for example, an SGSN address and IMSI to the VLR. The VLR stores the SGSN address and acknowledges by sending a message «Location updating accept».

9. The new SGSN confirms the presence of the MS in the new routing area RA. If there are no restrictions for registration of the MS for the new RA, the SGSN creates MM and PDP contexts for the MS. A logical link will be established between the new SGSN and the MS. The new SGSN replies to the MS with a message «Routing area update accept» including for example, a new TLLI. This message informs to the MS that the network has succeeded in carrying out the update.

10. The MS acknowledges the new TLLI with a message «Routing area update complete».

21. In a preferred embodiment of the invention the new SGSN which detects that the old location area identifier belongs to another SGSN immediately initiates the establishment of a logical link by sending a SABM (set asynchronous balanced mode) command

of the LAPG protocol (link access procedure on the «G» channel) to the mobile station. This command includes the same TLLI the mobile station used in the Routing Area Update Request message. On receiving the SABM command the mobile station resets the state variables ((VS), V(A) and V(R) to value 0), counters and timers. In the invention the reception of the SABM command preferably also includes setting LLC link parameters to their default values in the MS. Such LLC link parameters include the maximum delay (T200) of the acknowledgement response of a data frame, maximum number (N200) of retransmissions of a frame, maximum number (N201) of octets in the information field of a frame and maximum number of sent unacknowledged frames, namely the size of the acknowledgement window is K. Resetting of state variables according to the invention also includes a timer measuring the delay T200 and resetting of a retransmission counter N200. In general, it can be the mentioned above that the update of a logical link includes all necessary initializations in different protocol layers in the MS. The MS replies by sending a UA response (Unnumbered Acknowledgement) to the SGSN. The SGSN performs the initialization of the state variables, link parameters, counters and timers at its own end and thus the logical link has been established.

The MS also preferably totally discontinues data transmission to the SGSN until it has received a Routing Area Accept message from the SGSN in step 9.

In another embodiment of the invention the new MS that detects that the old location area identifier belongs to another SGSN, immediately starts the establishment of a logical link by initiating a procedure of the LLC layer that the MS and SGSN employ for negotiating the mentioned above LLC link parameters. For this purpose the MS sends a XID command according to the LAPG protocol to the SGSN, the command including a parameter message. The parameter message includes the values requested by the MS for LLC link parameters T200, N200, N201 and K. The SGSN sends a XID response including a list of the parameter values the SGSN supports. The MS and SGSN set these values to the parameters.

Naturally, the SGSN may use another suitable signaling sequence for initiating the establishment of a logical link in the LLC layer or in another protocol layer too.

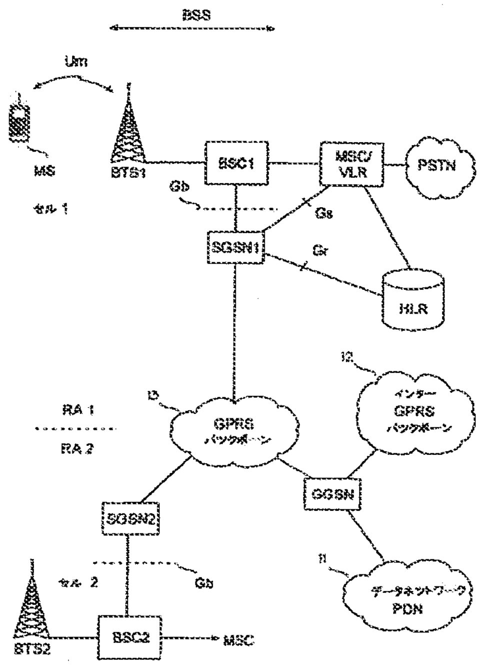
21'. The establishment of a logical link described in item 21 may be alternatively performed at any point, for example, after the Routing Area Accept message has been sent, as represented with LLC signaling 21'

in Drawing 3. However, this delays the initiation of data transmission after the update procedure.
11. In another embodiment of the invention the SGSN includes information that the MS should initiate the activation of the PDP context (contexts) in the Routing Area Accept message (for example, in the cause field). The SGSN adds this information at least if the search for a PDP context (contexts) from the old SGSN has failed. When the MS receives the information «activate PDP contexts», it performs the update of a logical link described above and initiates the activation of a PDP context (contexts) by sending a message (messages) «Activate PDP Context Request» to the SGSN.

Standardization of the GPRS system has not been completed yet. The present state of the GPRS system is described in recommendations GSM 03.60 version 0.20.0 and GSM 04.64 version 0.0.1(DRAFT) of the European Telecommunications Standards Institute (ETSI) that are incorporated herein by reference.

The description only illustrates preferred embodiments of the invention. The invention is not, however, limited to these examples, but it may vary within the scope and spirit of the appended claims.

Drawing 1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BTS1
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BSC1
MSC/ VLR
PSTN
Gb
Gs
SGSN1
Gr
HLR
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インター GPRS バックボーン
13
GPRS バックボーン
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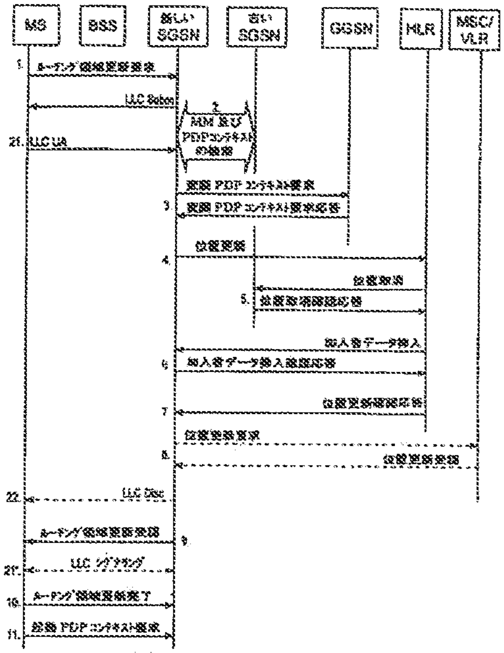
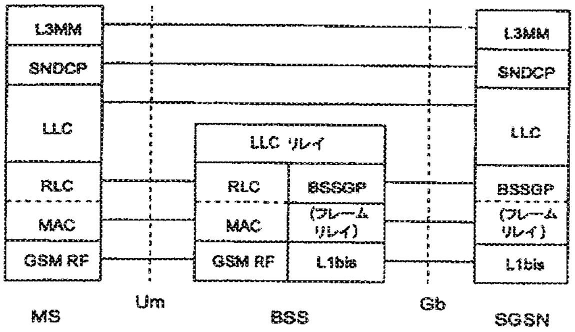
BTS2
BSC2
MSC

Drawing 3


MS
BSS
新しい SGSN
古い SGSN
GGSN
HLR
MSC/ VLR
1.
ルーティング領域更新要求
LLC Sabm
2.
MM 及び PDPコンテキストの転送
21.
LLC UA
更新 PDP コンテキスト要求
3.
更新 PDP コンテキスト要求応答
位置更新
4.
位置取消
5.
位置取消確認応答
加入者データ挿入
6
加入者データ挿入確認応答
位置更新確認応答
7
位置更新要求
8.
位置更新受諾
22.
LLC Disc
ルーティング領域更新受諾
9.
21'.
LLC シグナリング
ルーティング領域更新完了
10.
起動 PDP コンテキスト要求
11.

Drawing 2


L3MM
SNDCP
LLC
RLC
MAC
GSM RF
MS
Um
LLC リレイ
RLC
MAC
GSM RF
BSSGP
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L1bis
BSS
Gb
L3MM
SNDCP
LLC
BSSGP
(フレーム リレイ)
L1bis
SGSN